



# Regional Haze

*MA DEP SIP Steering Committee Meeting*

**January 5, 2006**

# What is regional haze?

- Visibility impairment caused by the cumulative emission of air pollutants from numerous sources over a wide geographic area.
- The primary cause of visibility impairment is the scattering and absorption of light by fine particles.

Great Gulf Wilderness 125 Mm-1  
21  $\mu\text{g}/\text{m}^3$   
25 dv



Great Gulf Wilderness 35.8 Mm<sup>-1</sup>  
8 µg/m<sup>3</sup>  
13 dv



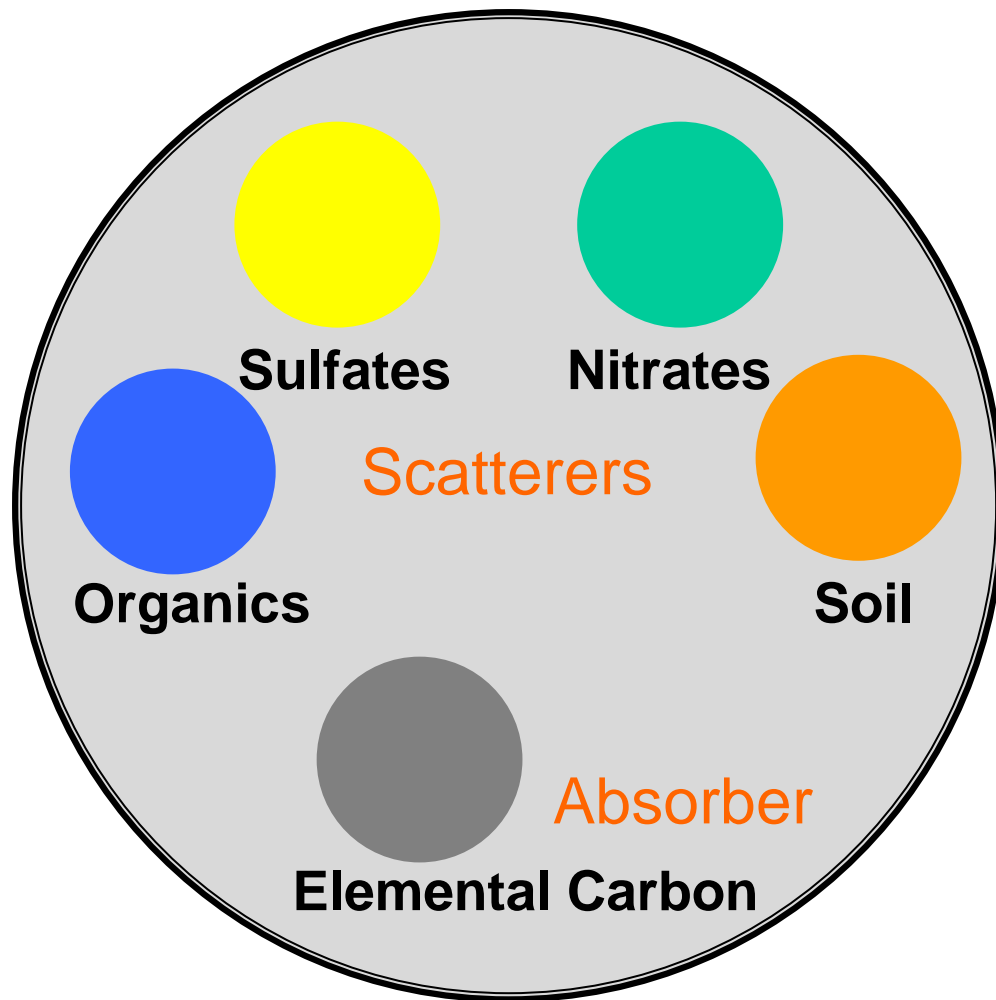
# Where do fine particles come from?

Local emissions including mobile, stationary and area source emissions

Transported emissions, particularly from large  $\text{SO}_2$  sources

Meteorological transport and atmospheric chemistry lead to the formation of secondary pollutants which are incorporated into fine particles

# What do fine particles consist of?



# Calculating Total Light Extinction

$$b_{\text{ext}}(\text{Mm}^{-1}) = b_{\text{SO}_4} + b_{\text{NO}_3} + b_{\text{OC}} + b_{\text{Soil}} + b_{\text{Coarse}} + b_{\text{ElemC}} + b_{\text{Ray}}$$

$$b_{\text{SO}_4} = 3[(\text{NH}_4)_2\text{SO}_4]f(\text{RH})$$

$$b_{\text{NO}_3} = 3[\text{NH}_4\text{NO}_3]f(\text{RH})$$

$$b_{\text{OC}} = 4[\text{OC}]$$

$$b_{\text{Soil}} = 1[\text{soil}]$$

$$b_{\text{Coars}} = 0.6[\text{Coarse}]$$

$$b_{\text{ElemC}} = 10[\text{EC}]$$

$$b_{\text{Ray}} = \text{Rayleigh Scattering}$$

$$f(\text{RH}) = \text{Relative humidity adjustment factor}$$

$$[ \quad ] = \text{concentration in } \mu\text{g}/\text{m}^3$$

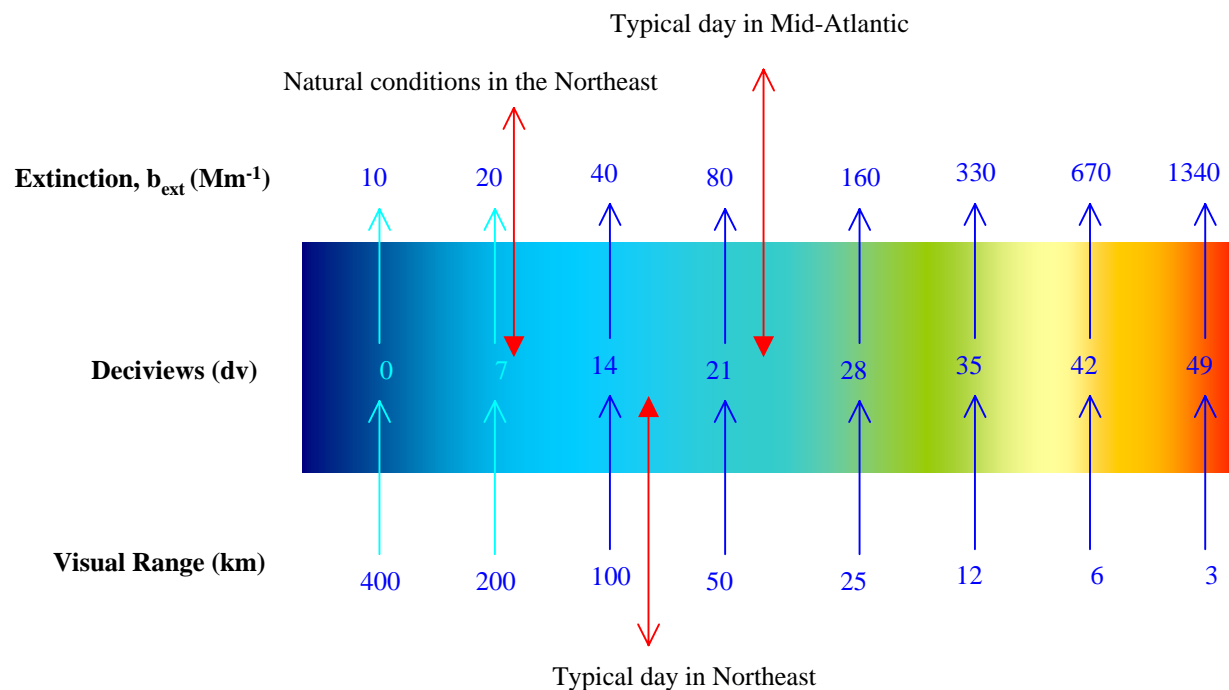


# Measures of Visibility

$$\text{Extinction Coefficient } (b_{\text{ext}}) = b_{\text{SO}_4} + b_{\text{NO}_3} + b_{\text{OrgC}} + b_{\text{Soil}} + b_{\text{coarse}} + b_{\text{ElemC}} + b_{\text{Ray}}$$

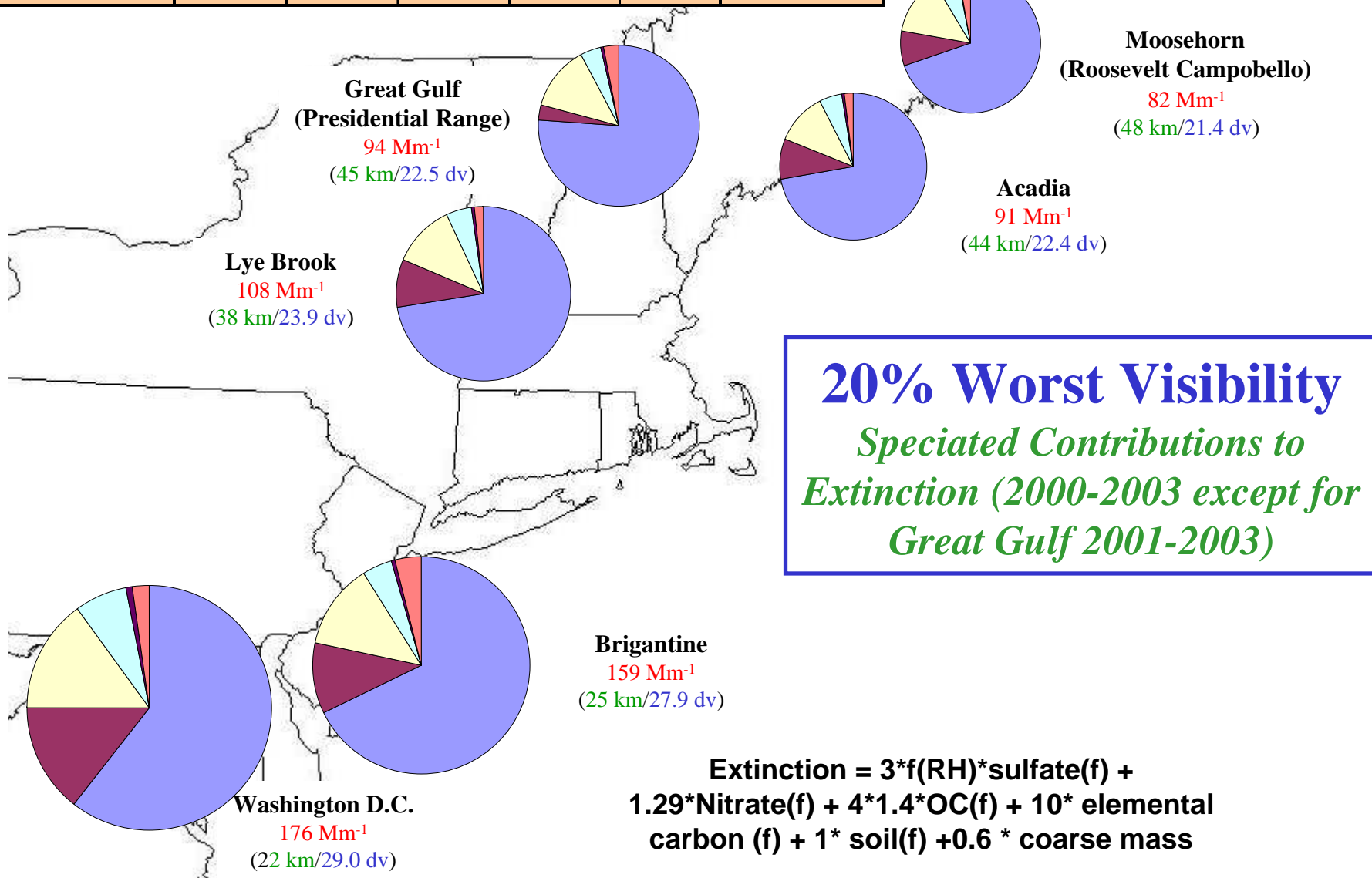
$$\text{Visual Range (km)} = 3.912 / b_{\text{ext}} \text{ (km}^{-1}\text{)}$$

$$\text{Deciview (dv)} = 10 \ln (b_{\text{ext}} / 10 \text{ Mm}^{-1})$$





Site	percent contribution to particle extinction					
	Sulfate	Nitrate	Org C	Elem C	Soil	Coarse Mass
Acadia	72	9	11	5	0.6	2
Moosehorn	70	8	14	5	0.5	3
Lye Brook	72	9	12	5	0.6	2
Brigantine	68	11	13	5	0.6	4
Washington DC	61	14	15	7	0.7	2
Great Gulf	76	3	13	4	0.6	3

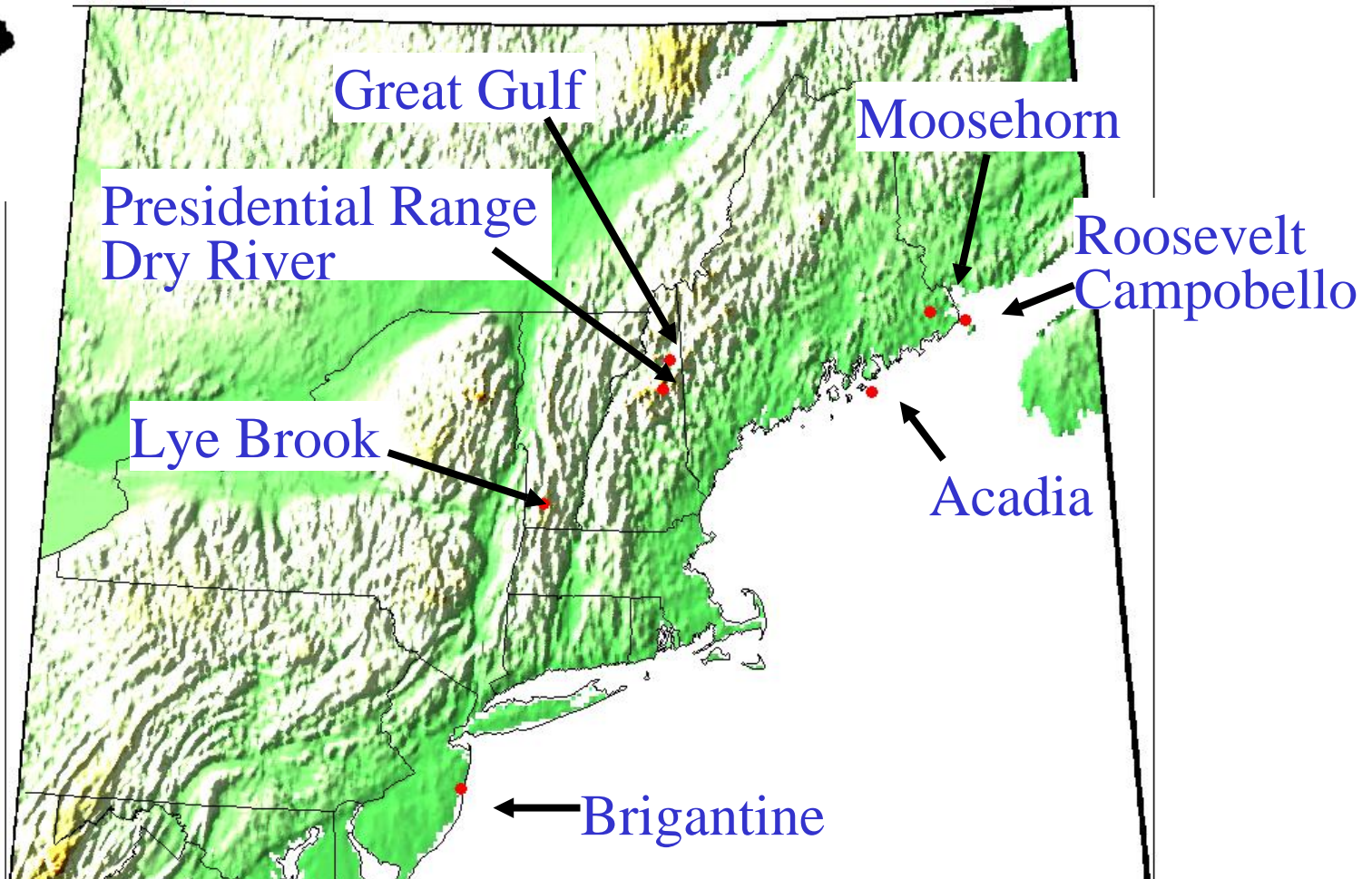


# What are Applicable Rules?

- **Final 1999 Regional Haze Rule (7/1/99)**
  - [http://www.epa.gov/ttn/oarpg/t1/fr\\_notices/rhfedreg.pdf](http://www.epa.gov/ttn/oarpg/t1/fr_notices/rhfedreg.pdf)
- **Final Clean Air Visibility Rule (6/20/05)**
  - **Preamble**  
[http://www.epa.gov/oar/visibility/pdfs/preamble\\_2005\\_6\\_24.pdf](http://www.epa.gov/oar/visibility/pdfs/preamble_2005_6_24.pdf)
  - **Final BART Guidelines**  
[http://www.epa.gov/oar/visibility/pdfs/guidelines\\_2005\\_6\\_24.pdf](http://www.epa.gov/oar/visibility/pdfs/guidelines_2005_6_24.pdf)
- **Website for all regulatory actions related to visibility**
  - <http://www.epa.gov/oar/visibility/actions.html>

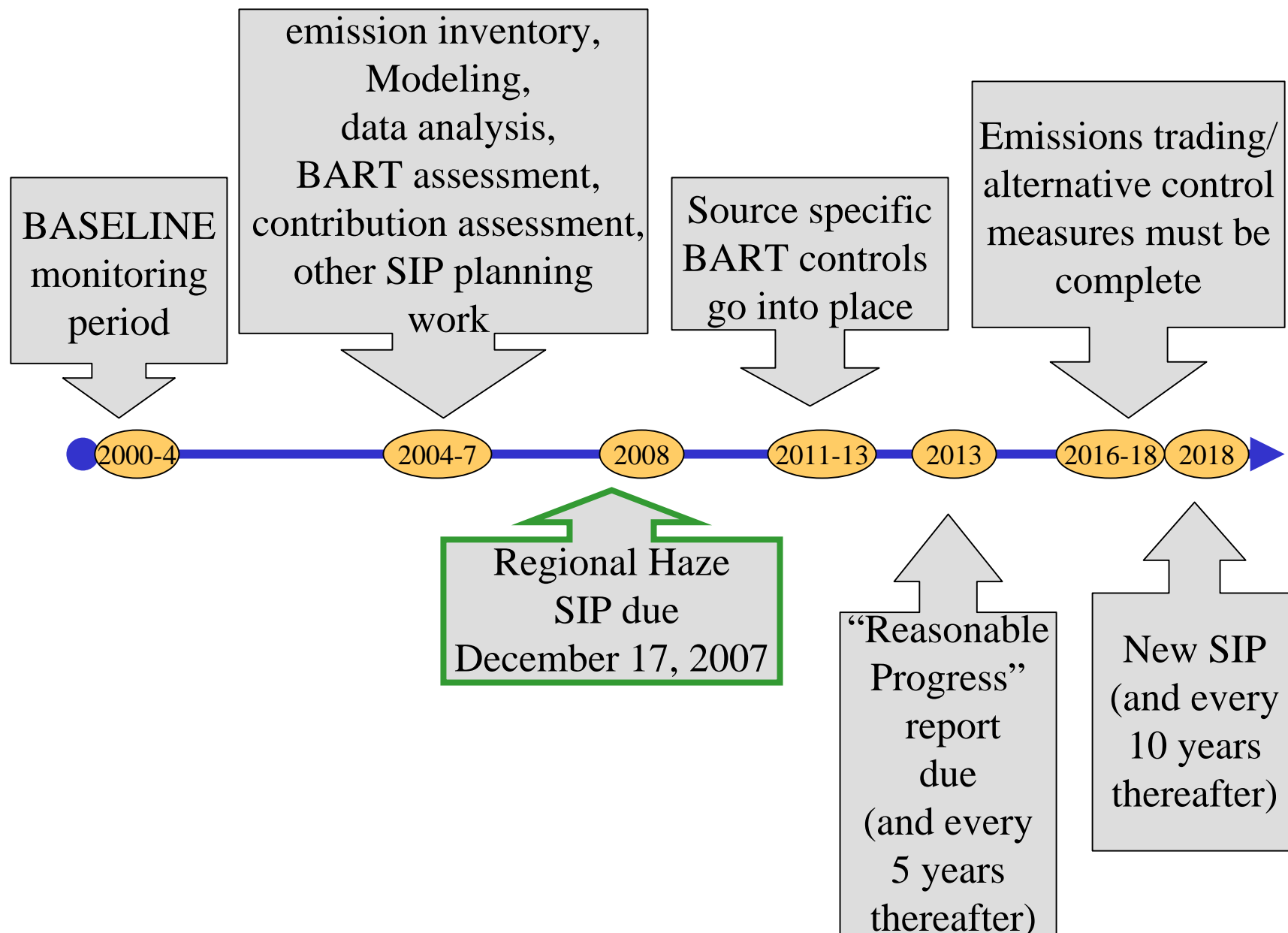
# What is the goal of the 1999 regional haze rule?

- To achieve natural background visibility conditions (pristine conditions) in all Class I Areas by 2064. 156 national parks and wilderness areas in the United States are designated as Class I Areas.

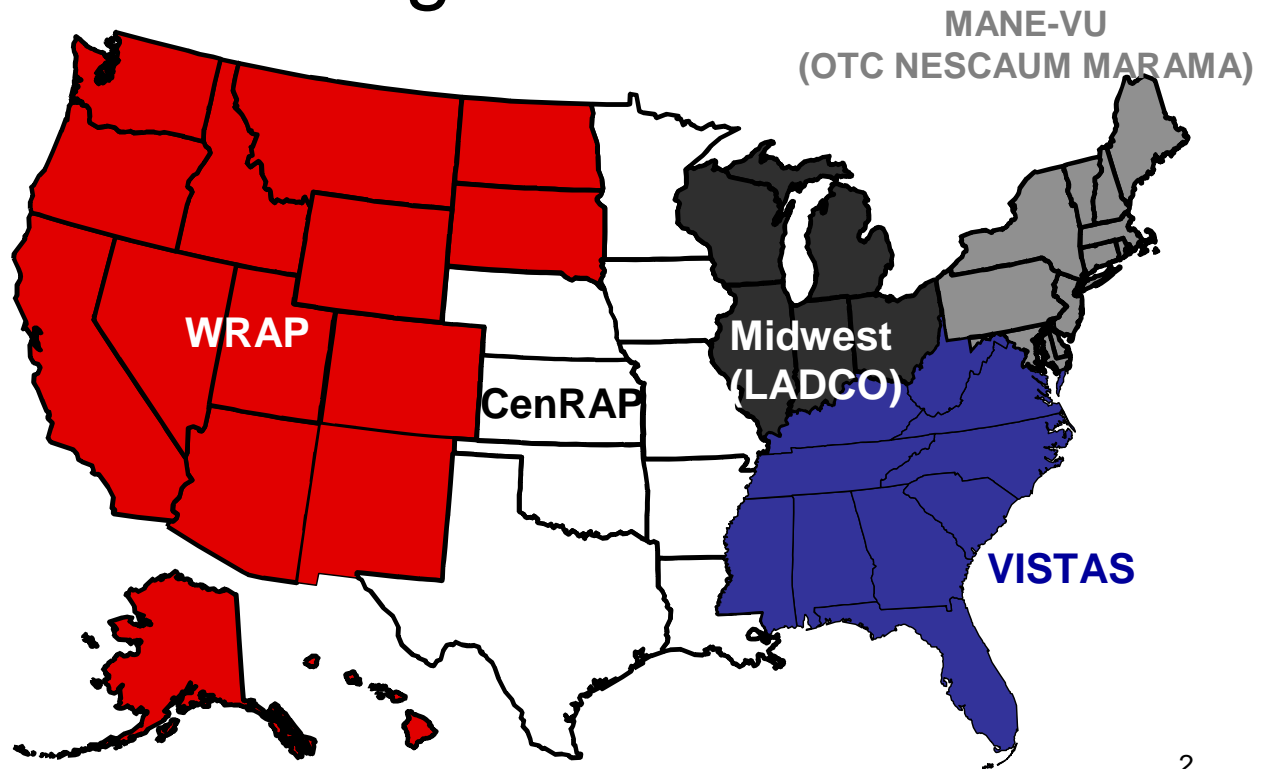


# Class I areas in the MANEVU RPO Region

# REGIONAL HAZE SIP TIMELINE

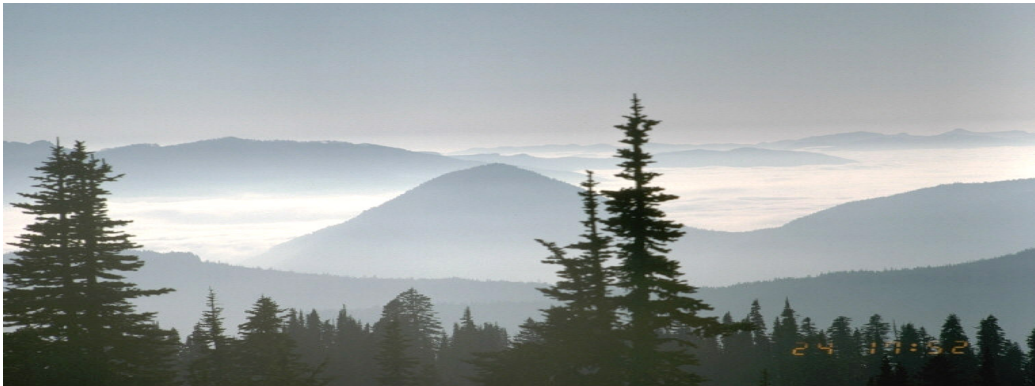


# Regional Planning Organizations



# Core Requirements of Regional Haze Rule

- Calculation of Baseline & Natural Visibility Conditions
- Reasonable Progress Goal
- BART
- Long-term Strategy (control measures needed to achieve reasonable progress)





# Calculation of Baseline & Natural Visibility Conditions

# Baseline Visibility Conditions

## Class I State SIP

### Section (d)(2)(i) of 40 CFR 51.308

- Baseline Period is 2000-2004
- Average impairment for most and least impaired days for each calendar year
- Compile the average of three annual averages
- Need the most representative available monitoring data

# Natural Visibility Conditions Class I State SIP

## Section (d)(2)(iii-iv) of 40 CFR 51.308

- Data from most impaired days
- Data from least impaired days
- Use EPA Guidance for estimating natural visibility conditions in Class I area

# Visibility in MANE-VU Class I Areas

	Est Baseline Worst 20% Days (in deciviews)	Est. Natural Visibility Worst 20% Days (in deciviews)
<b>Maine</b>		
Acadia National Park	22.86	11.45
Moosehorn Wilderness	21.53	11.36
Roosevelt Campobello	21.53	11.37
<b>New Hampshire</b>		
Great Gulf Wilderness	TBD	11.30
Presidential Range	TBD	11.30
<b>New Jersey</b>		
Brigantine Wilderness	27.92	11.28
<b>Vermont</b>		
Lye Brook Wilderness	24.24	11.25

Determine Reasonable Progress  
Goal for Class I Area

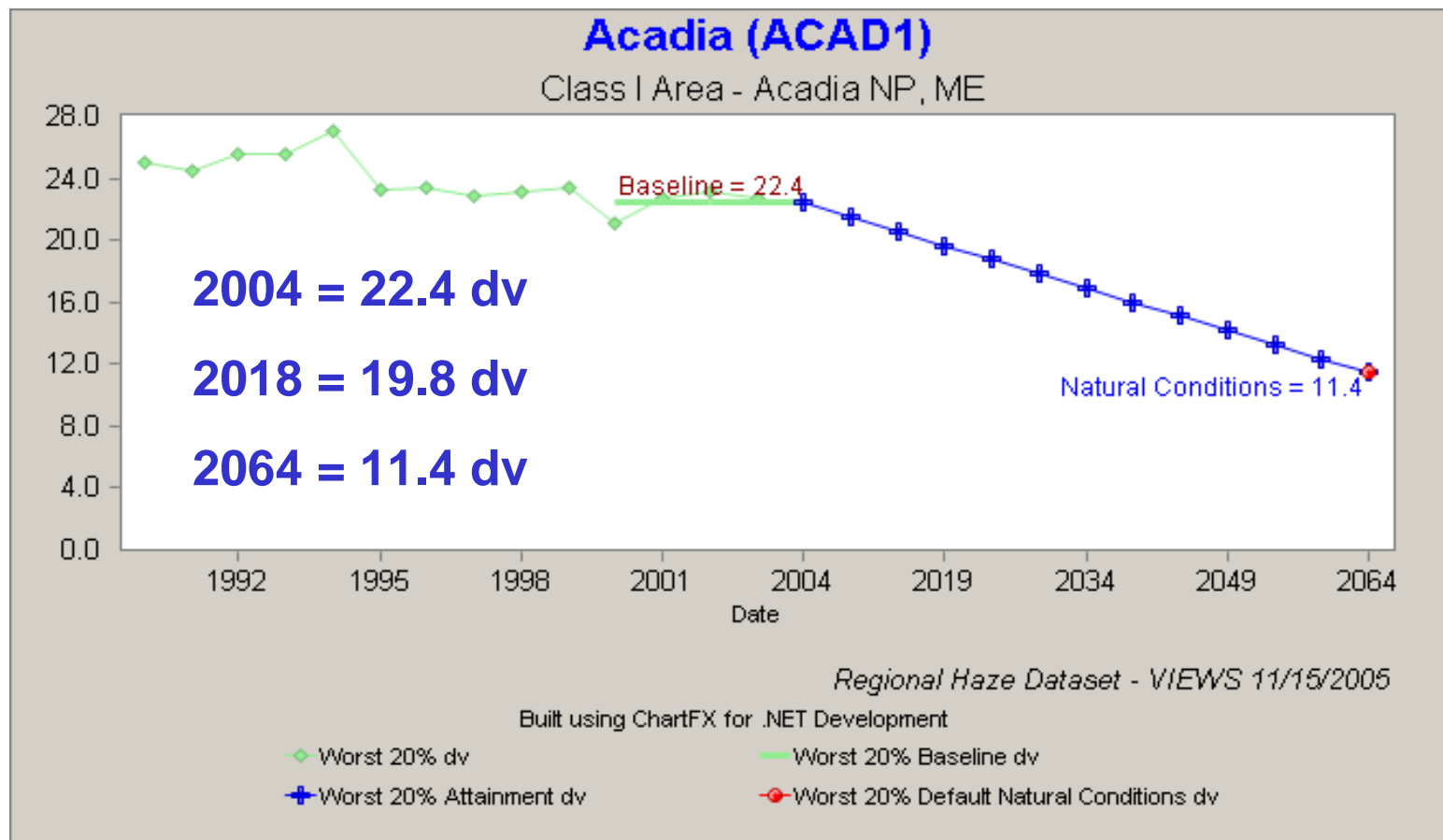
# Reasonable Progress Goal

## Class I State SIP

### Section (d)(1) of 40 CFR 51.308

- Establish baseline visibility (2000-2004)
- Estimate natural visibility conditions
- Estimate 2018 “Goal” to reach natural conditions by 2064 (Presumptive Goal)
- Estimate emission reduction required to reach 2018 “Goal”

# Reasonable Progress Goal Glidepath for 20% Worst Days at Acadia Park





# “Acceptable” Reasonable Progress Goal for Class I State SIP

- Consider a uniform rate of improvement between baseline and natural conditions
- Ensure no degradation in visibility for least impaired days
- If SIP establishes a slower rate of reasonable progress, State must:
  - 1) Demonstrate reasonable progress in light of factors required to consider.
  - 2) Calculate how many years would be needed at the slower rate to achieve natural visibility.
  - 3) Provide for public review.

# Implement BART Controls in States Impacting Class I Areas

# Best Available Retrofit Technology

## Source State SIP

### Section (e) of 40 CFR 51.308

- List all BART-eligible sources
- Determine which sources contribute to visibility impairment – those require BART
- Determine BART for each source
- Justify sources that are exempt
- May examine/establish a trading program

# BART Eligible Sources

- 1) Are in one of 26 source categories as identified in the Clean Air Act (see next slide)
- 2) Have units that were in existence on August 7, 1977, but had not been in operation for more than 15-years as of that date (prior to August 7, 1962)
- 3) Have the potential to emit of 250 TPY or more of any single visibility impairing pollutant from units that satisfy criterion #2. These pollutants include SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub> and under some circumstances VOC's and ammonia.

# 26 BART Categories

- Power Plant
- Coal Cleaning
- Kraft Pulp
- Portland Cement
- Zinc Smelter
- Iron and Steel
- Aluminum Ore
- Copper Smelter
- Incinerator
- Acid Plant
- Petroleum Refinery
- Lime Plant
- Phosphate Rock
- Coke Oven Battery
- Sulfur Recovery
- Carbon Black
- Lead Smelter
- Fuel Conversion
- Sintering
- Secondary Metal
- Chemical Plant
- Boilers
- Petroleum Storage
- Taconite Ore
- Glass Fiber
- Charcoal Production

# BART ENGINEERING ANALYSIS

- **Identify all available Retrofit Control Technologies**
- **Eliminate technically infeasible options**
- **Evaluate control effectiveness of remaining control technologies**
- **Evaluate impacts and document the results**
  - Costs of compliance, energy impacts, non-air quality environmental impacts and remaining useful life
- **Evaluate visibility impacts**
  - Develop modeling protocol
  - Run model at pre-control and post-control emission rates and calculate net visibility improvement
- **BART Resource Book (NESCAUM)**
  - Roadmap to assist states with the engineering analysis
  - Draft will be available for review - late December 2005

Prepare Long-term Strategy (control measures) to Achieve Reasonable Progress in Class I Areas



# Long Term Strategy Requirement Source State SIP

Section (d)(3) of 40 CFR 51.308

Required for each Class I area affected by  
emissions from the state

Must include enforceable emissions limits  
and compliance schedules

Must help achieve reasonable progress goal

# Long Term Strategy

## Source State SIP

Section (d)(3)(i-iii) & (i)(2) of 40 CFR 51.308

- States must consult with each other and FLMs
- State must document basis for its share of reductions
- Strategy must achieve reductions agreed to through RPO process

# Long Term Strategy Factors

## Source State SIP

Section (d)(3)(v) of 40 CFR 51.308

At minimum, the state must consider

- Ongoing air pollution control programs
- Measures to mitigate construction impacts
- Emissions limits & schedules to achieve goals
- Source retirement & replacement schedules
- Smoke management techniques
- Anticipated net effect on visibility due to changes during the period
- Enforceability

# SIP Technical Analyses

- **Emission Inventories (2002, 2012, 2018)**

- **Models to be used**

Evaluate Control strategies (CMAQ)

Estimate State contributions (REMSAD, CALPUFF)

BART visibility impacts (CALPUFF)

- **Weight of evidence techniques**

Trajectory analysis

Source apportionment techniques (PMF and UNMIX)

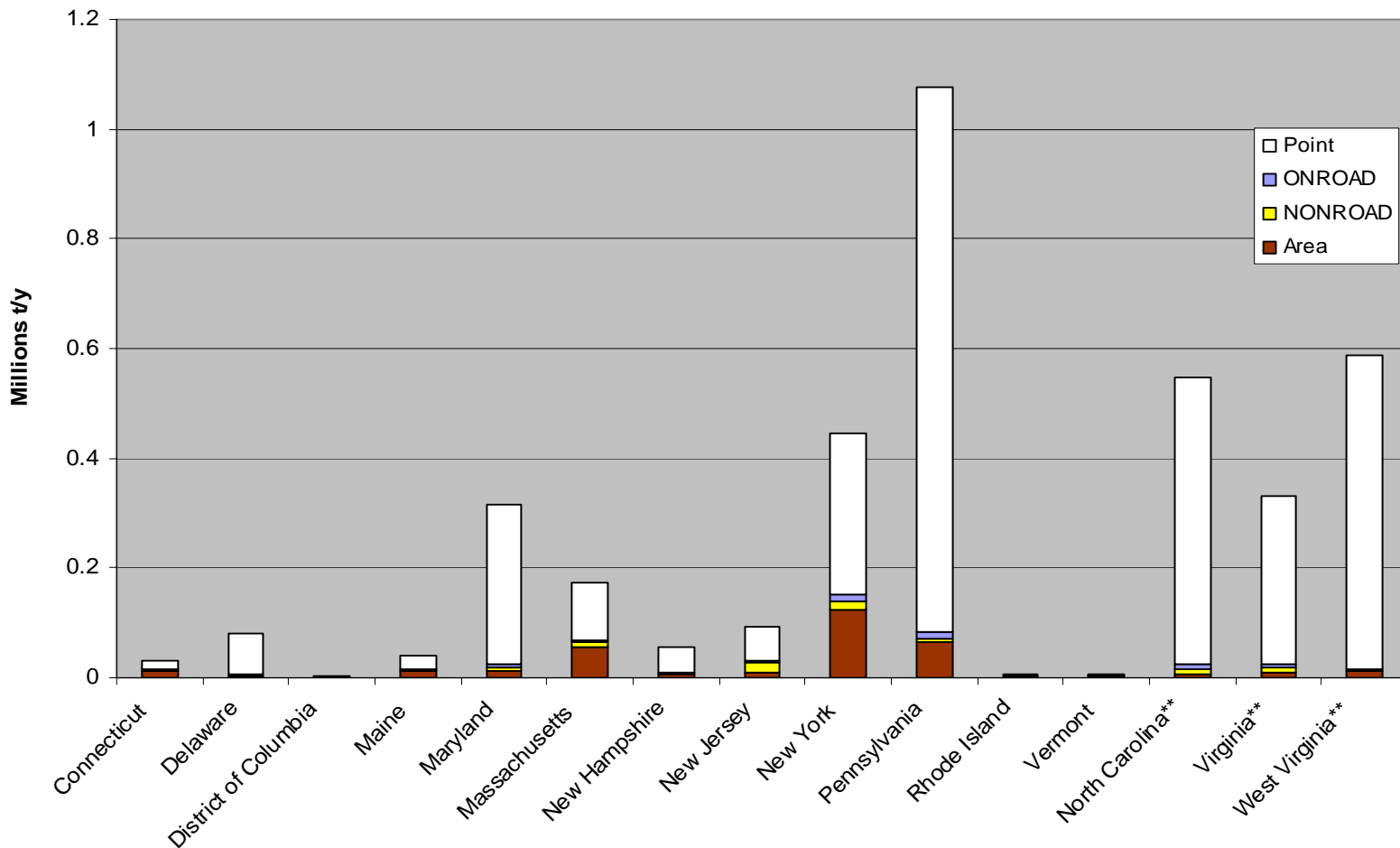
Trends analysis

# Weight of Evidence techniques

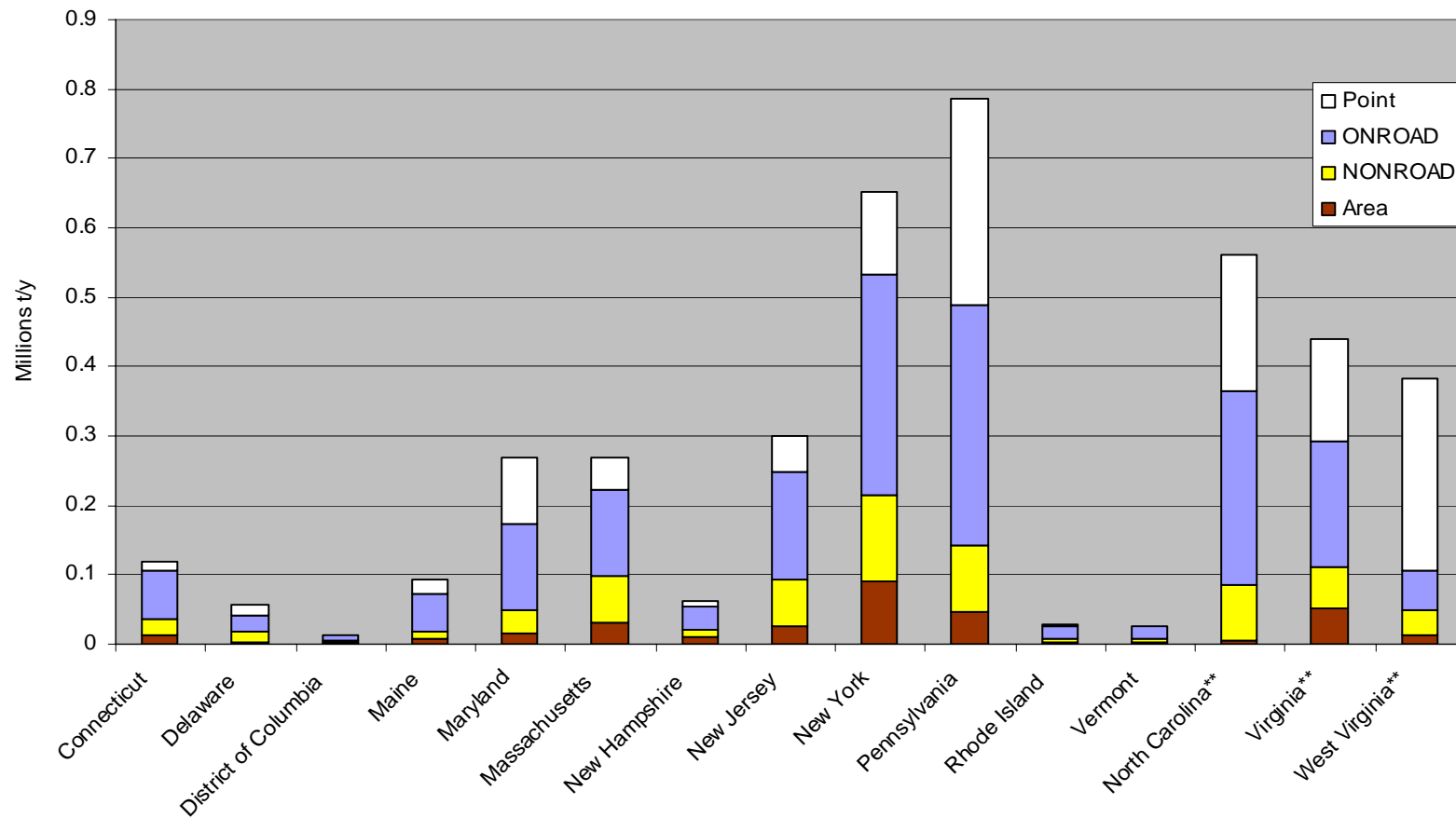
**Table ES-1: Summary of technical approaches for attributing state contributions to observed sulfate in MANE-VU Class I areas.**

Analytical technique	Approach
Emissions/distance	Empirical
Incremental Probability	Lagrangian trajectory technique
Cluster-weighted Probability	Lagrangian trajectory technique
Emissions x upwind probability	Empirical/trajectory hybrid
Source Apportionment Approaches	Receptor model/trajectory hybrid
REMSAD tagged species	Eulerian source model
CALPUFF with MM5-based meteorology	Lagrangian source dispersion model
CALPUFF with observation based meteorology	Lagrangian source dispersion model

# MANEVU 2002 Annual SO2 Emissions



# MANEVU 2002 Annual NO2 Emissions





- **MANE-VU developed future year modeling emission inventories for 2009, 2012, and 2018. These inventories are available in SMOKE/IDA and/or NIF 3.0 format and can be found at <ftp.marama.org>**

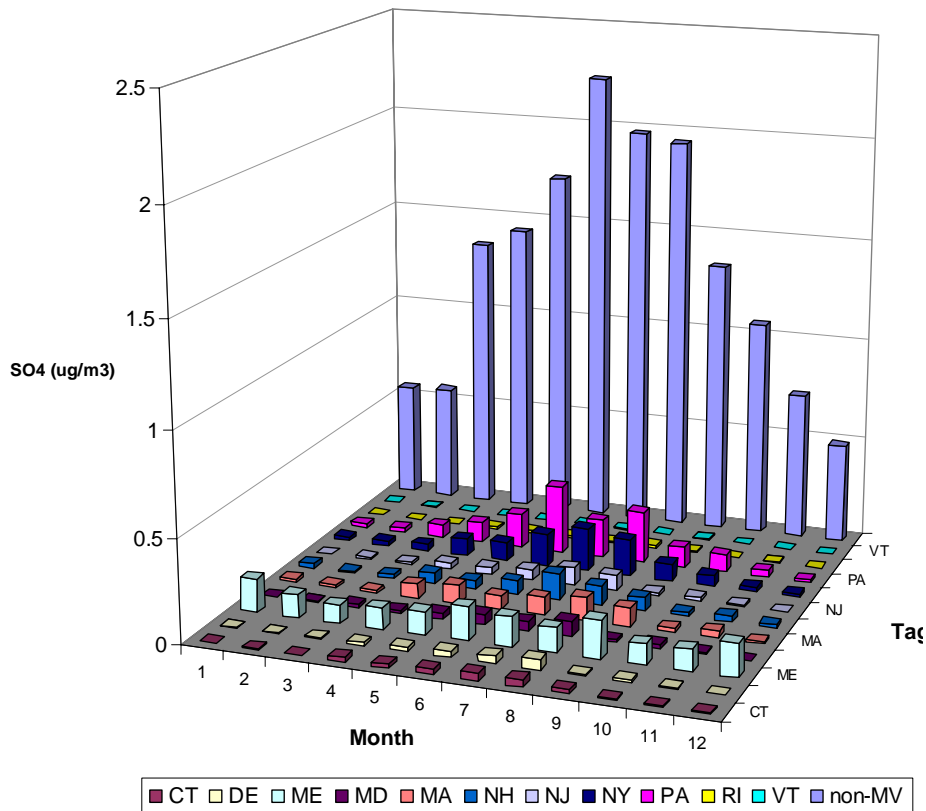
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Password: emissions

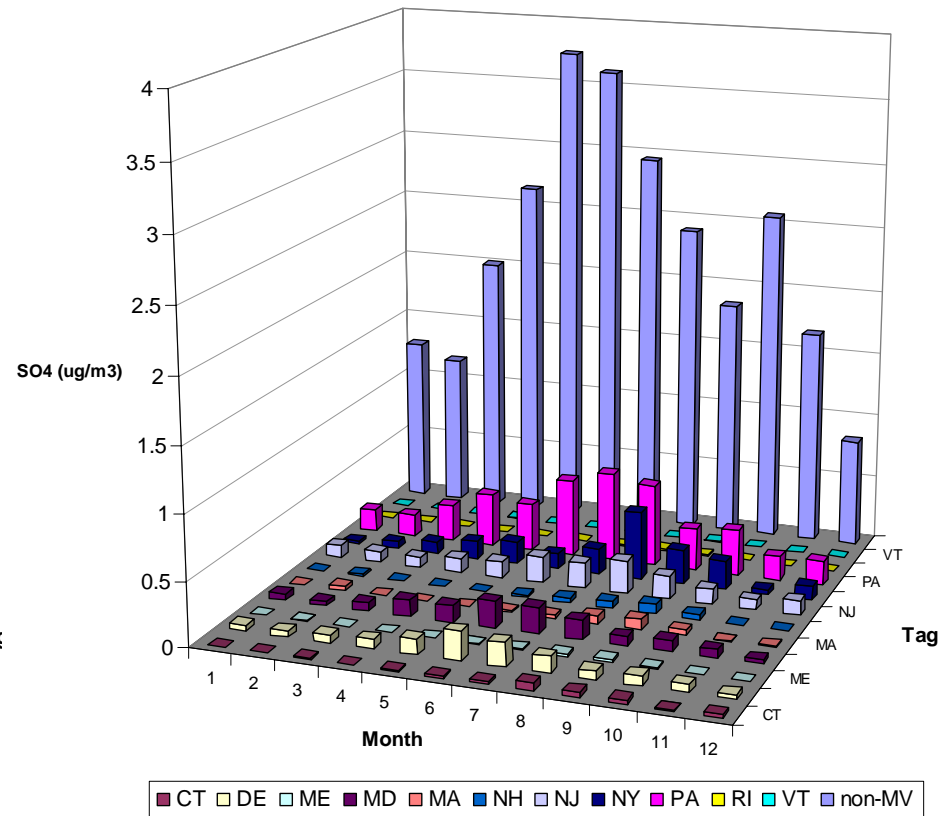
- **Data Summaries** for 2009, 2012, and 2018 will be available shortly

# Contribution analysis

(Monthly average sulfate concentration)

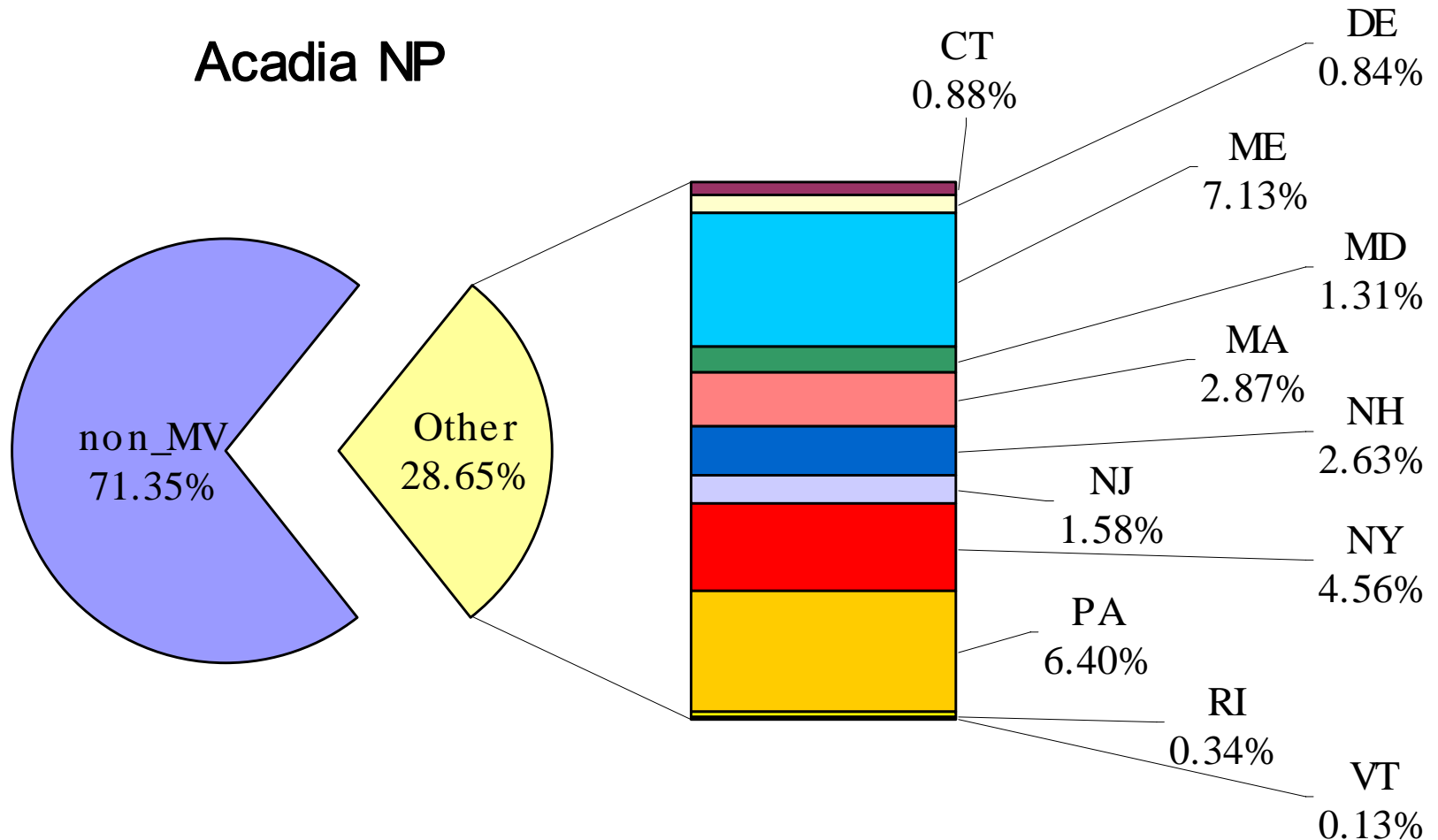


Acadia NP



Brigantine NWR

# Contribution to PM sulfate in a receptor site



# NEXT STEPS

- **Assess relative contribution from each state for each Class I area**
  - Finalize modeling/analyses with/most up-to-date data
  - Finalize NESCAUM contribution assessment report (January 2006)
- **BART engineering analysis**
  - Finalize BART-eligible source list for each state
  - NESCAUM will use CALPUFF model to determine impacts on Class I areas.
- **Assess the relative and absolute emission reductions needed to achieve the desired rate of progress**
  - Consultation between all States affecting each Class I area
  - Minimum reductions will include CAIR and any other measures needed to meet BART requirements, and to attain the ozone and PM<sub>2.5</sub> NAAQS.
  - Further reduction beyond CAIR appear to be needed to achieve progress consistent with the uniform rate of progress. If that rate cannot be achieved, the SIP must explain why.

# 2002 12km CMAQ Base Case Simulation

Centers	Sim.Period	Anal.Period
UMD	12/15/2001 to 2/28/2002	1/01/2001 to 2/28/2002
ORC	2/15/2002 to 5/14/2002	3/01/2002 to 4/30/2002
NYSDEC	5/01/2002 to 9/30/3002	5/15/2002 to 9/30/2002
VADEQ	9/15/2002 to 10/30/2002	10/1/2002 to 10/30/2002
NESCAUM	10/15/2002 to 12/31/2002	11/1/2002 to 12/31/2002